June 5, 1956 R. J. LITTLE ET AL 2,749,454

ELECTROMAGNETIC FLASHING RELAY

Filed Aug. 28, 1953 3 Sheets-Sheet 1

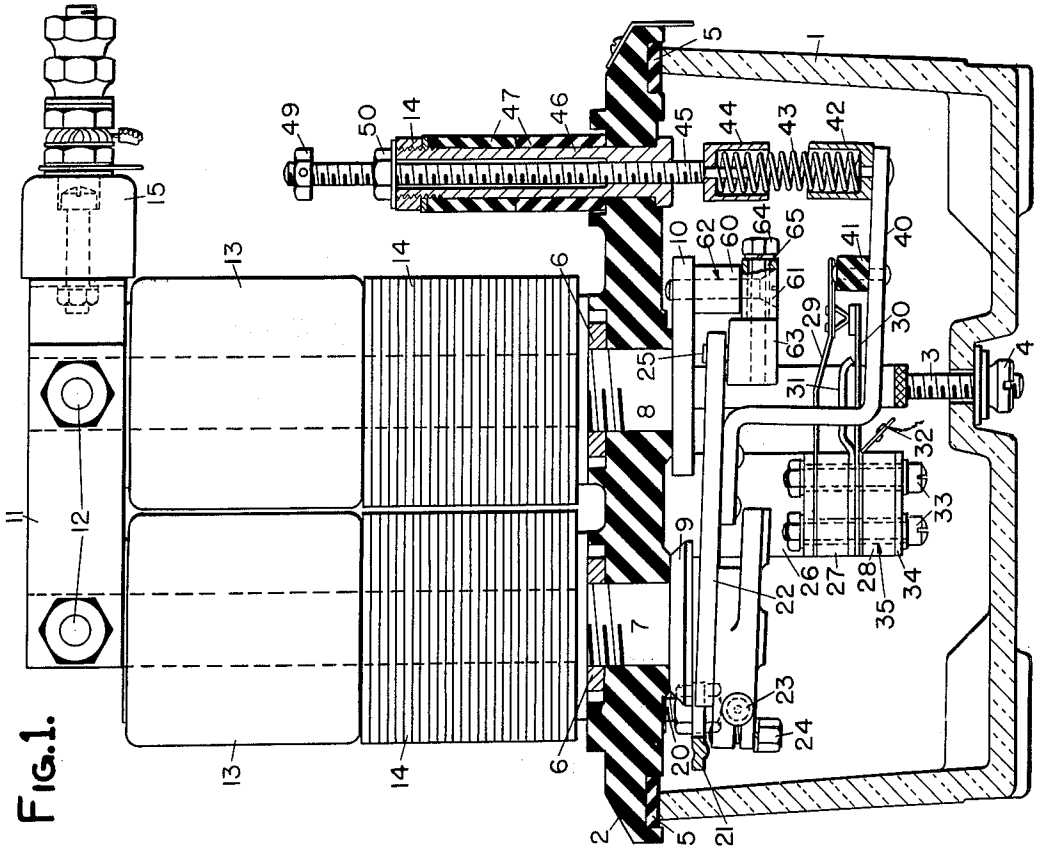


FIG. 1.

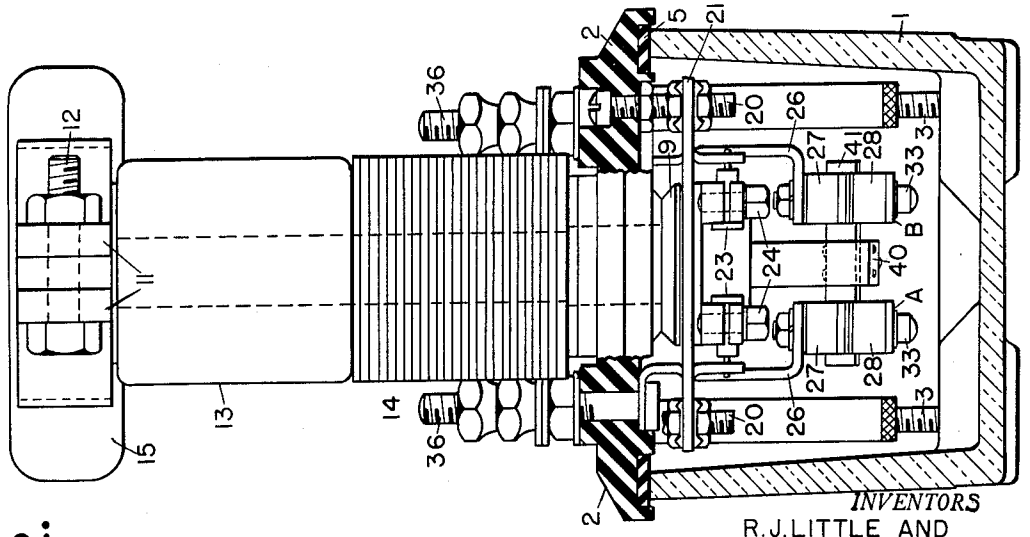


FIG. 2.

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FIG. 3.

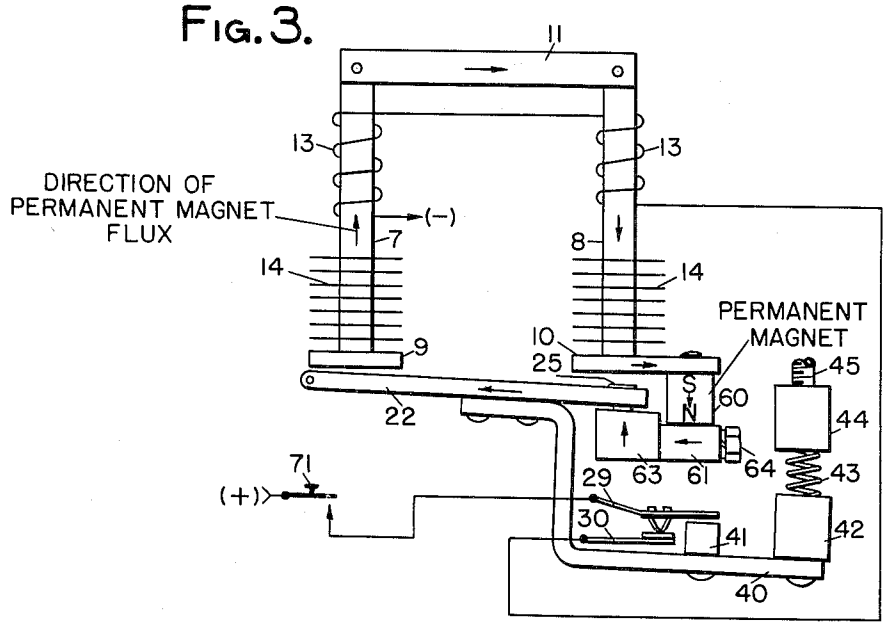


FIG. 4.

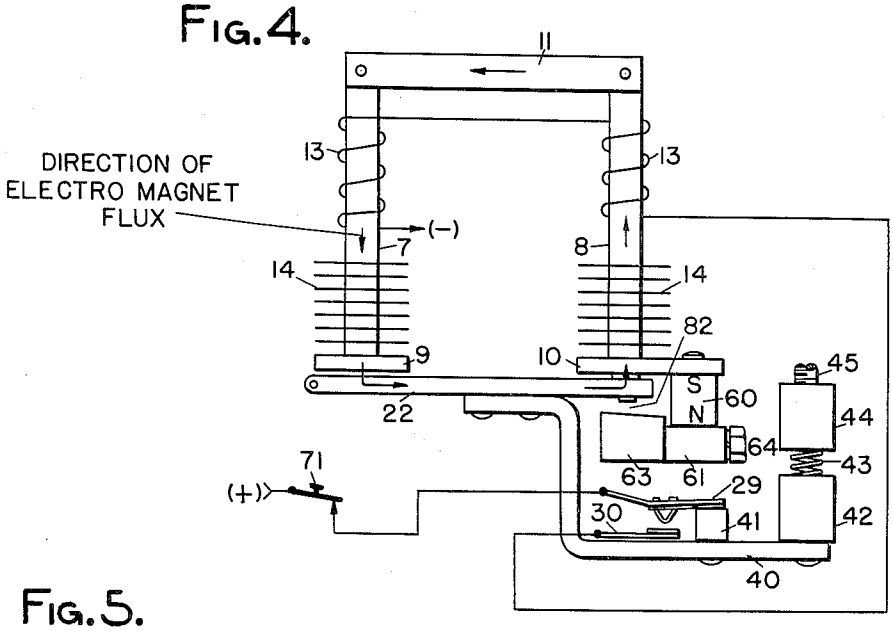
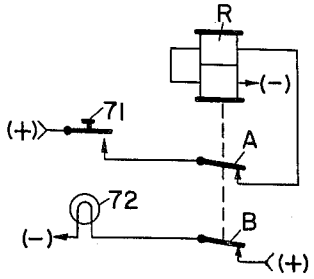


FIG. 5.



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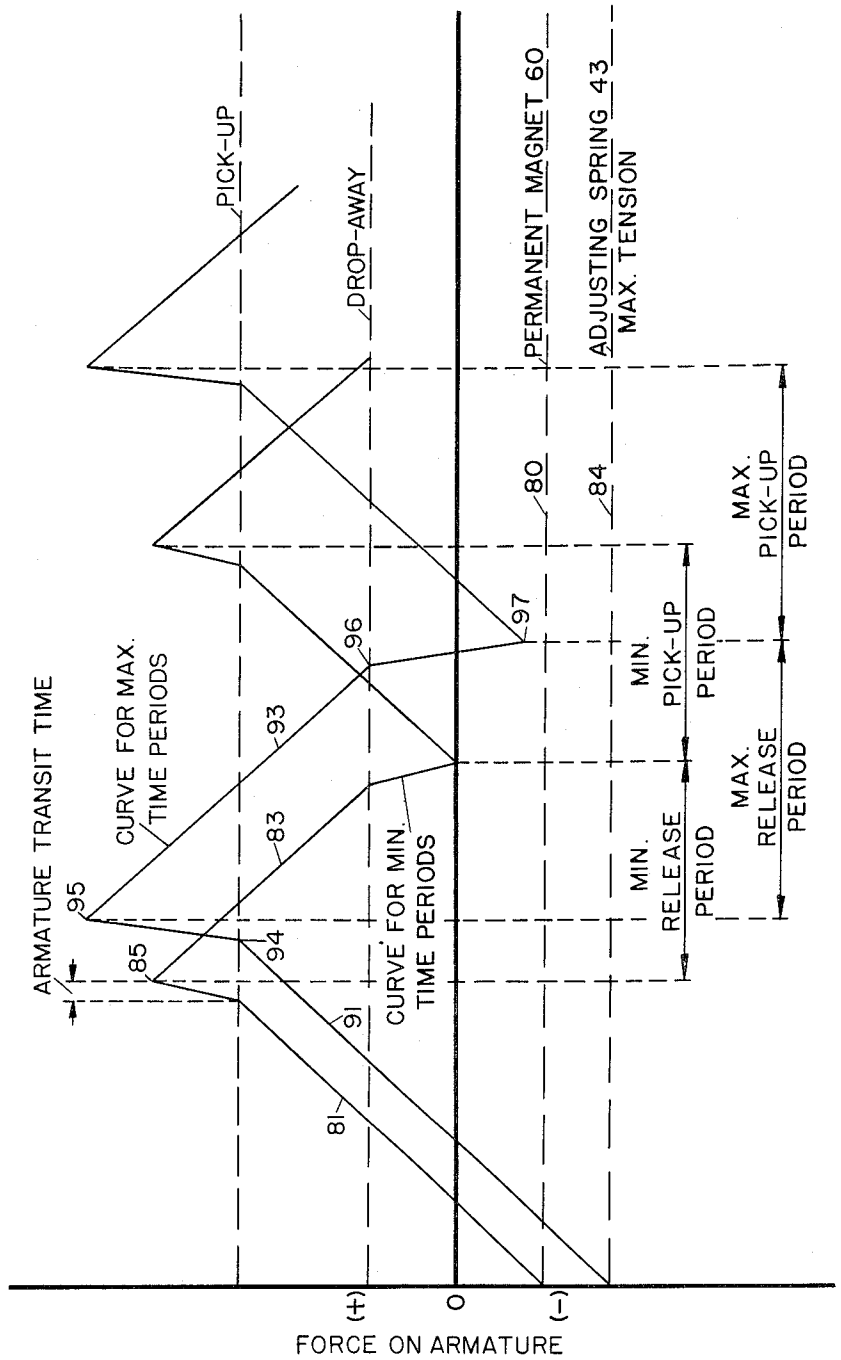


FIG. 6.

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ELECTROMAGNETIC FLASHING RELAY

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Application August 28, 1953, Serial No. 377,034

5 Claims. (Cl. 310—32)

This invention relates to electromagnetic relays, and more particularly pertains to a relay adapted for use in railway signalling systems to provide flashing signal indications.

Generally speaking, railway signalling systems employ flashing signal indications for various purposes such as at highway crossings to warn highway traffic of approaching trains, as a "call-on" signal to supplement the regular indications of the main signal, and as a fourth indication for a block signalling system. Although the relay of the present invention is particularly adapted to serve in a block signalling system where the fourth indication is a "flashing yellow," it is to be understood that the relay of this invention can be used for any purpose where its characteristics are adapted to provide the desired control.

One of the necessary characteristics of a relay used for the purposes mentioned above is that the time of operation of its aramture to its opposite positions should be substantially the same so that the "on" and "off" periods of an associated signal lamp will be substantially equal. This usually has been accomplished in the past by a dual magnetic structure acting on the same armature with each portion of the structure having the same characteristics. The present invention proposes to provide a flashing relay in the form of a simple neutral relay, which is simple in operation as well as durable and inexpensive to build. The present invention also contemplates the use of a simple neutral relay with auxiliary attachments provided thereon to give the desired slow action to the armature and permit adjustment of the timing interval between operations of the armature.

More specifically, it is proposed in accordance with this invention to provide a hold-down permanent magnet for the neutral armature which has its holding magnetic circuit in common with the operating magnetic circuit of the relay, with the relativity of the forces involved being of such a character as to provide an equalization of the armature operating and release intervals when the common magnetic circuits are provided with short circuited windings. In addition, it is proposed to provide adjusting means for giving a range of variations in the timing characteristics.

Other objects, purposes, and characteristic features of the present invention will be in part obvious from the accompanying drawings and in part pointed out as the description of the invention progresses.

With reference to the accompanying drawings, wherein like parts will be referred to by like reference characters:

Fig. 1 is a sectional view in side elevation of one form the relay of the invention may assume;

Fig. 2 is a sectional view of the relay as viewed from the rear;

Fig. 3 is a diagrammatic view showing the flux path from the permanent magnet when the relay is in a de-energized position;

Fig. 4 is a diagrammatic view showing the flux path when the relay coils are energized;

Fig. 5 is a simplified circuit arrangement to illustrate the operation of the relay; and

Fig. 6 is a diagram shown to illustrate in a general way the operational principles involved.

With particular reference to Figs. 1 and 2 of the drawings, there has been shown a conventional type of neutral armature relay with certain attachments added thereto to make the relay, when energized, function as a flasher. This relay comprises, in general, a housing or molded glass case 1 upon which is mounted a Bakelite top or cover 2. Threaded studs or bolts 3 protruding from the top 2 pass through holes in the bottom of the glass case 1 so that the top and case can be fastened together with nuts and washers 4, a gasket 5 being inserted between the two parts to provide a moisture proof housing for the relay contacts and other essential parts.

Mounted in the relay top 2 and held in place by nuts 6 are two steel cores 7 and 8, these cores being formed with enlarged pole shoes 9 and 10 at their lower ends which are located within the relay casing. These cores 7 and 8 extend upward from the relay top 2 and are connected together with a yoke 11 by means of bolts 12. Mounted on each of the cores 7 and 8 is a coil 13 and several copper washers or slugs 14, for reasons explained hereinafter. A terminal block 15 is fastened to the yoke 11 to facilitate wiring connections to the coils 13.

Suitably mounted to the relay top 2 by bolts 20, is an armature support 21 which is positioned inside the relay case 1. This armature support 21 provides a support for the relay armature 22 which is pivotally mounted thereon by means of trunnion bearings 23 and lock screws 24. The armature 22 is positioned directly under the pole shoes 9 and 10 and is provided with a residual pin 25 to provide an air gap between the armature and pole shoes when in its attracted position.

Suspended from the relay top 2 are two hanger brackets 26 which serve as the mounting means for the contact assemblies. These contact assemblies are constructed to provide a non-bounce feature which is described and claimed in the prior patent of Robert J. Little, Patent No. 2,682,586, dated June 29, 1954, and need not be described in detail herein. Generally, these contact assemblies comprise two molded insulation contact blocks 27 and 28, a movable contact finger 29 and a stationary contact finger 30 provided with a limit arm 31 and a wire connecting tip 32. Each assembly is supported on a hanger bracket 26 and held together by means of bolts 33 which pass through holes in all the parts, the hanger bracket 26 acting as one end plate and a face plate 34 acting as the other end plate to form a secure clamping means. The contacts 29 and 30 are insulated from each other by means of the insulated contact blocks 27 and 28 and insulated tubes 35 surrounding the bolts 33. The hanger brackets 26 also serve to carry current from an outside source to the contact fingers 29 by means of the binding posts 36 which also hold the hanger brackets in position on the relay top 2. The wire connecting tip 32 of the stationary contact 30 is also connected by a flexible wire to a binding post (not shown) leading to the outside of the housing.

Riveted to the armature 22 and extending downward from and parallel to the armature 22, is a contact operating arm 40. This contact operating arm carries a cross piece 41 of insulating material which cooperates with both movable contact fingers 29 and is adapted to break contact between the fingers 29 and 30 when the armature is operated to its closed position. Also riveted to the contact operating arm 40 at its extreme outer end is a cup shaped retainer 42 which is adapted to receive one end of a coil

spring 43. The other end of the coil spring 43 is also positioned in a cup shaped retainer 44 which is fastened to the relay top 2 in some suitable manner. This coil spring 43 acts to bias the armature 22 to its deenergized position and preferably should be adaptable to adjustment so as to vary the bias. In the form shown in the drawings, this is accomplished by mounting the cup shaped member 44 on the end of a threaded rod 45, which rod extends through the relay top 2 to the outside of the housing to facilitate adjustment from the outside. This threaded rod 45 is mounted in a sleeve bushing 46 which in turn is mounted in the relay top 2. The sleeve bushing 46 is surrounded with insulating sleeves 47 to prevent accidental short circuiting and the various parts are held together by a nut 48 threaded onto the sleeve bushing 46. The threaded rod 45 is provided with a nut 49 pinned thereon to facilitate turning and after proper adjustment of the spring bias has been made the threaded rod 45 is locked in place with a lock nut 50.

Referring now more particularly to the magnetic structure of the relay, from the description thus far given, there has been described what is commonly known as a neutral armature type relay having copper slugs or short circuited windings 14 placed on the cores 7 and 8 to make the operation of the relay slow acting, due to the fact that when the coils 13 are energized, the copper slugs retard the building up of flux in the magnetic circuit which causes the armature 22 to be slow in picking up. Similarly, when the coils 13 are deenergized, the flux is slow to decay and the armature 22 is slow in dropping away to its lower position.

When a neutral relay is provided with short circuited windings or copper washers 14 to make it slow acting, the actual transit time of the armature is also lengthened. In other words, the armature moves rather sluggishly and in some cases, it will make a partial movement and then wait for sufficient build up of flux to complete its movement. This stepped transit operation is of course dependent upon the load characteristics of the relay. Such stepped type of operation would be highly objectionable in a flashing type of relay, and has been overcome in the flashing relay of the present invention by the provision of holding means for the armature which is effective to maintain the armature in a deenergized position until the flux in the relay has built up to a value sufficient to positively operate the armature to its picked up position.

In the present form of the invention shown in the drawings, this hold down means is in the form of a permanent magnet 60. This permanent magnet is preferably of a suitable iron having a high coercive intensity, such as the commonly sold aluminum-nickel-cobalt-iron alloy developed by the General Electric Company and sold under the trade name "Alnico." This permanent magnet 60 is located beneath the armature 22 and when the armature is dropped away it provides a permanent magnet flux through the armature and the regular core structure which is effective to hold the armature in its dropped away position.

The magnetic path for this hold down feature is formed by placing the permanent magnet 60 on the underside of the extended pole shoe 10 and fastening same thereto by means of a steel block 61 and screws 62, all three pieces being mounted in a vertical position. Another steel block 63 is mounted to the first block 61 in a horizontal position by means of bolts 64 so that the second block 63 lies directly under the armature 22 and the complete assembly forms a U-shaped magnetic path from the pole shoe 10 around and to the underside of the armature 22. The block 61 is provided with enlarged holes 65 therein to receive the bolts 64 so that the block 63 can be adjustably mounted vertically with respect to the block 61. This forms a means of varying the distance between the underside of the pole shoe 10 and the top side of block 63 to thereby determine the amount of movement of the

armature 22 when moving from its deenergized to its energized position or vice versa. The residual pin 25 extends clear through the armature 22 and protrudes slightly on the underside to form an air gap between the armature 22 and the block 63.

Referring now more particularly to the diagram of Fig. 3, with the relay completely deenergized as shown, the flux from the permanent magnet 60 will follow a magnetic path as indicated by the arrows and the armature will be held in its retracted or lower position. This magnetic path may be traced from the permanent magnet 60 through the steel blocks 61 and 63, through the lower armature air gap to the armature 22, through the armature 22 and the air gap at the hinged end of the armature to the pole shoe 9, through the core 7, yoke 11, core 8 and pole shoe 10 back to the permanent magnet 60. All the various elements mentioned with the exception of the permanent magnet 60 are preferably made of silicon steel.

When the relay is energized from an outside control source such as for example, the closing of switch 71, current flows through the contacts 29 and 30 to the coils 13 connected in series and a new flux is produced in the cores 7 and 8 which will follow a typical neutral relay magnetic path which has been indicated by arrows in Fig. 4 and comprises the core 8, yoke 11, core 7 and pole shoe 9, through the air gap at the hinged end of the armature to the armature 22, from the armature 22 through the upper armature air gap to the pole shoe 10 and core 8.

As previously mentioned, the presence of the copper slugs 14 on the cores 7 and 8 will retard the building up of flux in the new magnetic path just described. As the flux produced by the electromagnet builds up in opposition to the permanent magnet flux, the net flux in the armature 22 is first reduced to zero and it then gradually builds up in the opposite direction particularly with considerable leakage flux between the armature 22 and the pole piece 10 of the core structure. This is because the permanent magnet 60 has a high coercive force and is in fact of such low permeability that it is difficult for the electromagnet flux to pass through the permanent magnet in opposition to the direction of its residual flux. For this reason, the leakage flux through the air gap and the pole piece 10 gradually builds up to a value which exerts sufficient pull to overcome the pull of the permanent magnet and the load on the armature, so that the armature abruptly and quickly picks up to its operated position. When the armature 22 picks up, it acts through its arm 40 on the contact finger 29 causing it to break away from its back contact 30. This breaks the energizing circuit for the electromagnet coils 13. However, the short circuited windings 14 are effective to allow the electromagnet flux to decay only slowly so that the armature remains in its operated position until the flux through it decays to a value which will no longer support the armature load.

The flux producing values of the coils 13 and permanent magnet 60 are so proportioned as to give a minimum of timing within a particularly selected range suitable for flashing purposes. In order to lengthen this range of timing and more particularly for the purpose of varying the length of the timing, an armature spring bias 43, as previously described, is introduced into the device for the purpose of further delaying the pick-up time of the armature. This spring bias requires more flux to be built up in the cores 7 and 8 before the armature 22 can be picked up and consequently requires a longer interval of time for the flux to decay and allow the armature 22 to drop away. The amount of spring bias against the armature 22 in its lower position can be varied by turning the threaded rod 45 down or up in accordance with the requirements.

Referring now briefly to Fig. 5 of the drawings, there has been shown a simple circuit diagram illustrating the control of a flashing light 72 by a relay such as described in the present invention. As previously described, this relay, which has been conveniently designated as R,

comprises two sets of contact assemblies **29** and **30** etc. which for convenience have been designated A and B. When the relay R is energized from an outside source, which may be another relay controlling a block indication of a railway signalling system, or for example, a switch **71** as shown, the armature will pick up after a short period of time as previously described in connection with Figs. 3 and 4. Upon pick up of the armature, contacts A and B will open, contact A breaking the circuit which supplies energy to the relay coils and contact B breaking a circuit which supplies energy to the light **72**. After another short period of time, required for the flux in the relay cores to decay, the relay armature will drop away and the contacts A and B will again be closed, thus causing the lamp in light **72** to light up and the relay coils to again become energized. As long as the switch **71** is closed this cycle will be repeated at short intervals causing the light **72** to flash on and off. In railway signalling practice, this flashing interval is generally in the neighborhood of 40 to 60 flashes per minute and may be regulated by adjusting the threaded rod **45** as previously described.

Merely by way of explanation, and no way in a limiting sense, a straight line diagram has been shown in Fig. 6 to illustrate in a general way certain principles involved. However, this diagram has not been drawn with a view of illustrating specific values and actual curves, and for this reason should not be considered to represent the exact operation of the relay.

In this diagram, the force on the armature **22** is plotted against time. Initially when the relay is deenergized, the force on the armature **22** is that supplied by gravity and in addition the pull provided by the permanent magnet **60**. Insofar as the diagram is concerned, only the permanent magnet pull has been indicated by the dotted line **80**.

The pull provided by the electromagnet is, of course, proportional to the current flow through the windings **13** and the flux passing through the core structure. This flux is, of course, retarded by the copper washers **14** so that the pull would rise along the line **81** indicated in the chart. However, since the permanent magnet flux is present, the net force acting on the armature **22** is represented by the rise along the curve indicated by the solid line **81** but starts at a negative value. When the armature **22** actually moves because the force on it is equal to its pick up value, the force of the permanent magnet **60** is substantially reduced because of the air gap **82** and in effect the net force on the armature **22** then rises to substantially that produced by the energization of the electromagnet without the permanent magnet **60**. This net flux at point **85** then present is not, however, as great a flux as would be present in the relay if the energization of the windings **13** were continued. This is because the copper washers **14** have delayed the rise in flux, so that it cannot reach a maximum value before the current is cut off by the opening of contacts **29—30**. Thus, the windings **13** are now deenergized, and the force on the armature **22** begins to decay. This is delayed by the copper washers **14** along the solid line **83** and when it reaches the dropping away value for the armature **22**, the armature rapidly releases and the closure of the magnetic circuit for the permanent magnet **60** abruptly adds its pull to the armature **22**. Because of the delay factor of the copper washers **14**, the net negative pull on the armature **22** does not reach as low a value as when the relay is steadily deenergized. Also, the closure of the back contacts **29—30** immediately energizes the windings **13** so that the rise in flux again takes place.

If this operation is repeated time after time, it is noted that the release and pick up periods of the relay are substantially equal and these periods are not as long as the initial pick up period of the relay.

It is apparent that the pick up and release periods of the relay are determined by the time that it takes for the flux in the relay to build up to a pick up value. Therefore, if the load on the relay is increased, this time will become greater. Such increase in load is effective to increase the time for both the pick up and release periods. This is because the build up of the flux must take place over a longer period; and because of this increased value of the flux, its time of decay is increased. Thus, the addition of a load by increasing the tension on spring **43** is in effect the same as increasing the strength of the permanent magnet. This increase of spring load is indicated by the dotted line **84**.

With the spring load, the force on the armature **22** now begins at a lower negative value at line **84** and rises along line **91** until it reaches the pick-up value of the relay. The armature then quickly moves from back to front in a relatively short transit time; and because the air gap between the armature and the permanent magnet is now greatly enlarged, the force of the permanent magnet on the armature is reduced to a very low value and the force supplied by the electromagnet to overcome such permanent magnet force now represents a positive force on the armature. Also, the electromagnet force, which is required to be supplied to overcome force of the adjusting spring **43**, is a substantial value of flux which consumes a longer time in building up; but when the armature reaches its front pole piece, the decreased air gap is effective to allow this flux to create a greater holding force on the armature. For this reason, the line **91** rises rapidly from the pick-up point **94** to the point **95**.

With this greater amount of flux in the core and armature (or resultant force on the armature), the decay of such flux requires a longer time to reach the drop away value, assuming that the copper washers are effective to maintain approximately the same rate of decay as when the spring tension was not present. This decay of force on the armature is represented by the line **93**, and when the drop away value is reached the armature abruptly drops away at which time the added force of the spring and permanent magnet are abruptly applied. This brings the line **93** from the drop away point **96** to the negative point **97**. During the transit time between points **96** and **97**, the contacts **29—30** are closed, so that the current in the windings of the relay again begins to build up.

This operation is, of course, repeated time after time until energy is removed from the relay. It is noted that with the spring tension present, the maximum release and pick up periods are substantially greater than the minimum release and pick up periods as indicated in Fig. 6. These illustrations are, of course, merely typical and are not intended to represent actual values.

In order for the time of the release and pick up periods to be in the order of 40 to 60 per minute in a relay of this type, it was found desirable in one structure to make the strength of the permanent magnet **60** approximately one-fifth that of the strength of the electromagnet. Also, it is desirable that the spring **43** be sufficiently resilient to supply the maximum added load when its adjusting range has been completely utilized. This makes it possible in manufacture of the relay to thread the screw **45** all the way to the end of its downward movement, thus assuring a maximum load on the armature **22** to prevent its vibration in shipment and also to prevent such vibration which would tend to cause the displacement of the spring **43**.

Having thus described a flashing relay structure as one embodiment of the present invention, it is desired to be understood that this form is selected to facilitate the disclosure of the invention rather than to limit the number of forms which it may assume: and, it is further understood that various modifications, adaptations and alterations may be applied to the specific form shown to meet the requirements of practice, without in any manner departing from the spirit or scope of the present invention.

What we claim is:

1. In a flashing relay structure of the type described, a U-shaped core structure having mounted thereon energizing windings and a plurality of copper washers, an armature pivotally mounted to cooperate with said core structure, a permanent magnet providing magnetic flux through said core structure and a back stop member for holding said armature in a released position, a coil spring for biasing said armature against said back stop, adjusting means for adjusting the tension on said coil spring, contacts operably connected to said armature, and circuit means including a source of energy, said windings, and said contacts for causing the energization of said windings only until said armature is at least partially actuated to an operated position, whereby said armature operates intermittently between said pole pieces and said back stop, such intermittent operation being at a substantially uniform rate.

2. In a flashing relay structure of the type described, a U-shaped core structure having operating windings located thereon and a substantial number of short circuited windings located adjacent the open ends of said U-shaped core structure, an armature pivoted adjacent the open ends of said U-shaped core structure, a permanent magnet being connected between said core structure and a back stop member for said armature, whereby said armature in a released position allows the passage of flux from said permanent magnet through said armature and said core structure to provide a predetermined holding effect to maintain said armature in a released position, a back contact connected to said armature, a circuit including said operating windings and said back contact in series with a source of energy, whereby said substantial number of short circuited windings is effective to delay the build up of flux to prevent the saturation of said core during the time in which said operating windings are energized, and is effective to delay the decay of flux to thereby prolong the release time of said armature for substantially the same period of time.

3. In a relay structure of the type described, a U-shaped core structure formed by a back strap connecting two cores and terminating with enlarged pole pieces, windings on said cores adjacent said back strap energizable with current to produce magnetic flux in a particular direction, a plurality of copper washers on said cores adjacent each of said pole pieces, a cooperating armature pivoted at one end and operable form a released position to an operated position adjacent said pole pieces, a permanent magnet, a magnetic extension of one of said pole pieces for mounting said permanent magnet, an adjustable back stop connected to said permanent magnet and extending beneath said armature, whereby said permanent magnet provides magnetic flux through said core structure and said back stop to normally hold said armature in its released positon, a spring biasing said armature against said back stop, and means for adjusting the tension of said biasing spring.

4. In a relay structure of the type described, a U-shaped core structure terminating at its open end into enlarged pole pieces, a cooperating armature adjacent said pole pieces and pivoted at one end adjacent one of said pole pieces, a permanent magnet connected at one end to the other of said pole pieces and having a magnetic extension extending to the back of said armature, whereby said armature is pivotally operated between said other pole piece and said magnetic extension, and whereby said permanent magnet causes magnetic flux to pass through said core structure while said armature is adjacent said extension, windings on said core structure adapted to be energized in a direction to oppose the magnetic flux of said permanent magnet, short circuited copper washers located on said core structure adjacent each of said pole pieces, and spring biasing means providing a preselected bias for said armature against said magnetic extension.

5. In a relay structure of the type described, a core structure including two parallel core members and a connecting back strap, said core members terminating in enlarged pole pieces, a pivoted armature adjacent said pole pieces, a permanent magnet having one end connected to one of said pole pieces and having a magnetic extension extending to the back of said armature, whereby said armature may be moved between said pole pieces and said extension, and whereby said permanent magnet causes magnetic flux to pass through said core structure in a particular direction when said armature rests against said extension, and windings on each of said core members adapted to be energized to produce magnetic flux in a direction opposite to that produced by said permanent magnet to cause said armature to be operated against said pole pieces, a plurality of copper washers on said core members between said windings and said enlarged pole pieces, an adjustable spring for biasing said extension, and circuit means including a back contact operated by said armature for energizing said windings only while said armature is in a released position and for a limited distance away from such released position.

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